A Retrospective View of the D&D Focus Area's Large-Scale Demonstration Program

Steven J. Bossart
U.S. Department of Energy
Decontamination and Decommissioning Focus Area
Morgantown, West Virginia

Robert W. Vagnetti
Waste Policy Institute
Morgantown, West Virginia

ABSTRACT

The U.S. Department of Energy's (DOE) Environmental Management (EM) Program, through its Office of Science and Technology (OST/EM-50) has been demonstrating and deploying innovative decontamination and decommissioning (D&D) technologies through its Large-Scale Demonstration Program (LSDP). Through the LSDP, innovative D&D technologies are demonstrated side-by-side with baseline technologies as part of active decommissioning projects. Performance data is collected on both the innovative and baseline technology to assist D&D project planners in deciding whether to incorporate the innovative technology into their baseline D&D project(s). Through this program, the D&D Focus Area expects to demonstrate innovative technologies that address at least 90 percent of DOE's D&D technology needs and problems by FY2002. This paper describes the implementation of creative management strategies to conduct the Large-Scale Demonstration Program and a summary overview of the first 18 months of the program.

I. INTRODUCTION

In FY1996, the D&D Focus Area implemented a new approach known as "Large-Scale Demonstration Projects" to demonstrate and evaluate innovative D&D technologies within the context of an ongoing DOE deactivation or decommissioning project. Ideally, the innovative D&D technology is evaluated side-by-side with a comparable baseline technology. Performance data is collected on the innovative and baseline technology, and is evaluated to assist D&D project managers and planners in determining whether an innovative technology has cost and other performance advantages over the baseline technology.

An Integrating Contractor (IC) Team manages the technology demonstration for each of the LSDPs. Typically, three or more experienced D&D firms comprise the IC Team, which also often includes participation from universities and site management and operating (M&O) or management and integration (M&I) contractors. The management of the LSDP by multiple D&D interests provides a balanced project management approach, due to the fact that different firms use different baseline technologies and have different perspectives on the benefits and risks of using new, innovative technologies. In addition, direct knowledge of the LSDP technology demonstrations is promptly transferred to the individual firms on the IC Team. With this first-hand knowledge, these D&D firms are able to deploy demonstrated technologies to conduct future D&D work at other DOE sites and commercial nuclear facilities.

The LSDP concept is a sound approach to qualify D&D technologies for DOE's Technology Deployment Initiative (TDI) which implements previously demonstrated technologies at multiple facilities. An innovative technology demonstrated in an LSDP qualifies for the TDI if the full-scale cost and performance data indicates that the innovative technology has advantages over the competing baseline technology.

II. BACKGROUND

Full implementation of the D&D Large-Scale Demonstration Program began in FY1996, yet the conceptual framework took shape a few years earlier. Between FY1994 and the beginning of FY1996, the D&D Focus Area held a series of planning workshops that included government, industry, regulator, and university participation. Some of the key conclusions from these workshops which helped to define the program as it currently exists included:

- For specific D&D problems a need exists to demonstrate complete “cradle-to-grave” solutions to which do not leave a legacy of secondary problems. This requires the integration of technologies to address all steps in D&D from characterization to waste disposal.

- Partnerships between DOE, contractors, industry, regulatory agencies, and academia are useful for bringing expanded expertise to technology development and deployment problems. These partnerships can help promote the transfer and infusion of innovative technologies and methods for application to D&D problems throughout DOE and the private sector.

- In general, sufficient baseline technologies exist to decommission surplus DOE buildings, structures, and their contents. However, many of these technologies, developed by the nuclear utility industry or the D&D firms that service this industry, have not been demonstrated within the DOE weapons complex.

- Many baseline technologies used for DOE's D&D tasks tend to be labor intensive and expensive; can unnecessarily expose workers to radioactive and other hazardous materials; and often produce unacceptable volumes of secondary waste.

- Regulators, DOE D&D managers, site (M&O or M&I) contractors, and D&D firms are often unwilling to accept the risk and liability associated with the first time use of a new technology that lacks adequate prior demonstration.

Based on these and other comments and conclusions from the workshops, the D&D Focus Area embarked upon a strategy to impartially evaluate the cost and performance of new technologies. That strategy included the following elements:

1. Within the LSDPs, the D&D Focus Area sponsors the first-time, full-scale demonstration of new technologies within the DOE complex, regardless of their origin (i.e., whether they are developed within or outside DOE/EM).

2. The fundamental requirements are to perform technology demonstrations as part of a real D&D project and at a scale that provides meaningful results.

3. The facility owner commits to deploy the technology within the project if its cost and performance merit such deployment.

Subsequent deployment of an innovative technology after a successful demonstration constitutes replacement of the previous baseline technology with the innovative technology. This new baseline technology establishes new and improved performance goals for other competing innovative technologies.

III. LARGE-SCALE DEMONSTRATION PROJECT IMPLEMENTATION

In July 1995 and again in May 1996, the D&D Focus Area began implementing the LSDP by issuing a competitive Request-for-Letter Proposals (RFLP) to all DOE Operations Offices requesting they offer facilities to host a LSDP. Table 1 depicts the types of facilities sought to host a LSDP as well as the types of facilities offered by the sites and selected by the LSDP selection committee. By selecting diverse types of facilities, the D&D Focus Area expects to demonstrate technical solutions to cost-effectively and safely address 90 percent or more of the D&D needs and problems identified by its customers. To date, the D&D Focus Area has selected five DOE facilities to host LSDPs, and plans to select three additional LSDPs.

Table 1. Types of Facilities for Large-Scale Demonstration Project Selection

Facility Type	RFLP #1 Responses	Selected	RFLP #2 Responses	Selected
Production And Test Reactors	4	2	1	-
Laboratory Facilities Including Hot Cells & Gloveboxes	1	-	4	-
Gaseous Diffusion Plants	-	-	2	1
Tritium Facilities	-	-	1	-
Plutonium Processing & Handling Facilities	-	-	2	1
Uranium Processing Facilities	3	1	1	-
Lithium Processing Facilities	-	-	-	-
Chemical Processing/Reprocessing Facilities	-	-	2	-
Weapons Production and Assembly Facilities	-	-	1	-
Totals	**8**	**3**	**14**	**2**

Chicago Pile 5 Test Reactor

The first LSDP selected was the Chicago Pile 5 (CP-5) Test Reactor Facility at Argonne National Laboratory - East. This LSDP is focusing on the removal of equipment from the reactor facility and decontamination of the facility for subsequent reuse. The CP-5 reactor, fueled by highly-enriched uranium and moderated and cooled by heavy water, was designed to supply neutrons for research. The CP-5 test reactor had a thermal power rating of 5 megawatts and was operated almost continuously for 25 years until its final shutdown in 1979 when the fuel rods were removed from the reactor and the heavy water was drained from the system.

The major work activities to be accomplished during the CP-5 LSDP include removal of the reactor internals and biological shield, decontamination of fuel rod storage area, hot cell decontamination, decontamination of the fuel pool water and structure, and decontamination of the reactor building including material storage and handling areas.

Plant 1 Uranium Processing Facility

The second LSDP selected was the Fernald Environmental Management Project (FEMP) Site where the focus is on the decontamination and dismantlement of the Plant 1 Complex. The Plant 1 Complex is part of the former Uranium Feed Materials Production Facility and consists of Building 1A which is a large, radioactively-contaminated, multi-story, process facility containing asbestos insulation, transite wall paneling, large process equipment, and utilities. Building 1A was

used to receive all enriched-uranium materials that were processed at Fernald. Additionally, non enriched ore concentrates and recycled materials were weighed, sampled, and milled in this plant prior to distribution to other process facilities. Activities to be accomplished during this LSDP include the decontamination and dismantlement of the buildings and their contents. The D&D of Plant 1 Complex is one of more than 20 work packages of similar scope to be completed in the next few years at the FEMP Site.

105-C Reactor

The third LSDP selected was Hanford's 105-C Reactor Interim Safe Storage Project. The 105-C Reactor, located within DOE's Hanford Reservation on the south bank of the Columbia River, is a full-scale weapons material production reactor. The reactor was built in 1952 and shutdown in 1969. The scope of this LSDP is to place the 105-C Reactor facility in a low-cost, safe-storage condition for up to 75 years pending its final disposal. Activities include demolition and removal of the building structure around the reactor block and removal of the fuel storage basin. The Interim Safe Storage Project will reduce the footprint of the 105-C Reactor facility by about 70 percent and significantly reduce future annual surveillance and maintenance costs.

There are 14 full-scale production reactors within the DOE weapons complex that stand to benefit from the 105-C Reactor work since the safe-storage concept is a low-cost, environmentally conscious, and practical alternative to immediate full-scale reactor building dismantlement. Five reactors are at the Savannah River Site and the other nine are at the Hanford Site. Commercial nuclear facilities as well as other contaminated DOE facilities, such as canyons and gaseous diffusion plants will also benefit from technologies demonstrated at the 105-C Reactor.

Building 779 Plutonium Process Development Laboratory

The fourth LSDP selected is the decommissioning of the plutonium process development laboratory in Building 779 at the Rocky Flats Environmental Technology Site. Building 779 is a two-story concrete facility with a floor space of approximately 65,000 ft^2. The building contains an assortment of laboratory equipment including about 100 gloveboxes and associated piping and ductwork. The facility will present a variety of challenges including decommissioning of loose and fixed plutonium contaminated material; organic contaminated material, and gloveboxes made from a variety of materials including stainless steel, aluminum, and asbestos. Using baseline technologies, decommissioning of the facility would be expected to generate low-level waste, low-level mixed waste, and transuranic waste. The endpoint for the LSDP is a decontaminated building ready for demolition.

Technology demonstration activities in the Building 779 LSDP may include facility characterization, worker protection/containment, robotics/dismantlement, facility and equipment decontamination, waste treatment, and material recycling. Based on a site-wide assessment, nine other buildings at Rocky Flats totaling over one million ft^2 that have similar problems and contamination levels as Building 779 stand to benefit from technologies demonstrated within this LSDP.

Building K-27

The most recently selected LSDP involves decontamination and dismantlement of three cells containing about 225 tons of gaseous diffusion plant process equipment and piping in Building K-27 at the Oak Ridge K-25 Site. This project will serve as the cornerstone for future decommissioning of 12 large process buildings at DOE's Oak Ridge, Paducah, and Portsmouth gaseous diffusion plants. These buildings cover about 25 million ft^2 of floor space and contain about 11,000 stages in 1,367 cells.

Each cell in K-27 contains six stages of process equipment. Each stage is comprised of two electric motors, centrifugal flow compressors, a converter containing the barrier material for separating uranium, and associated piping and valves. The K-27 Building is generally contaminated with uranium with localized areas of technetium-99 contamination. Technology demonstration opportunities may include real-time characterization, decontamination and dismantlement of equipment, waste minimization, worker safety and health, and metal recycling.

Scheduling and Timeline

Argonne CP-5 and Fernald Plant 1 were selected from the first RFLP and their schedules have been extended for completion in early to mid FY1998. The Hanford 105-C Reactor project, also selected from the first RFLP solicitation, is scheduled for completion at the end of FY1998. The Rocky Flats Building 779 and Oak Ridge K-27 projects were selected as a result of the second RFLP solicitation and both projects were provided funds for initial planning in June 1997. Full implementation of these latest two LSDPs begins in FY1998.

The implementation of each LSDP is scheduled to last 18 to 24 months, but may be influenced by the schedule and progress of the baseline D&D project. Based on the experience from the first three LSDPs, implementation consists of six to nine months of planning prior to actual technology demonstrations. The planning phase consists of identifying and prioritizing facility problem areas and technology needs; identifying, screening and selecting innovative technologies; identifying baseline technologies and approaches; negotiating vendor subcontracts to demonstrate technologies; developing test plans; and acquiring site approval, particularly from personnel responsible for site safety and health.

A. Integrating Contractor Team

Though each LSDP may be organized and managed differently, all aspects of each project are the responsibility of the Integrating Contractor Team. The D&D Focus Area allows each of the IC Teams to conduct its LSDP using its own procedures as long as the Focus Area's overall LSDP goals are attained in the project. Typically, three or more deactivation or decommissioning firms will make up the IC Team. In addition, the IC Teams are encouraged to include academia, nuclear utility firms, and regulatory agencies. The management of the LSDPs by multiple firms ensures a balanced approach to deactivate or decommission the DOE surplus facility, since different firms may use different commercial and innovative technologies and may have different perspectives on the risks associated with the use of innovative technologies. Table 2 displays the diverse makeup of the IC Teams for the first three LSDPs. The IC Teams for the latest two LSDPs at Oak Ridge and Rocky Flats are being finalized.

Table 2. Distribution of IC Team Members

	CP-5	Plant-1	105-C Reactor
D&D Service Companies	• Duke Engineering & Services	• Foster Wheeler Environmental • Jacobs Engineering • Halliburton-NUS • Babcock & Wilcox - NESI	• Bechtel National • Morrison Knudsen • CH2M Hill
Nuclear Utilities	• Duke Power • Commonwealth Edison		
Site (M&O/M&I) Contractor	• Argonne National Laboratory	• Fluor Daniel Fernald	• Bechtel Hanford
Technology Developers	• 3M Corporation	• Fluor Daniel Technologies	• AEA Technology – UK
Technology Brokers	• ICF Kaiser		• Montgomery Watson • Thermo Remediation • International Technology
Universities	• FIU		
Regulators			• Washington State Dept. of Ecology
Federal Management*	• DOE Chicago	• DOE Fernald	• DOE Richland • DOE Savannah River

* DOE-FETC (Morgantown) provides management oversight and the USACE provides technology cost and performance analysis for all LSDPs.

The role of the IC Team in the LSDP extends from its inception until the final project report is approved for release. Their responsibilities include:
identification of baseline technologies;

- identification of project's technology needs and problems;
- identification, screening and selection of innovative technologies;
- negotiation and contracting with technology vendors;
- development of demonstration test plans for innovative and baseline technologies;
- integration of demonstration activities into the baseline D&D project including oversight of subcontractors who own the innovative and baseline technologies;
- innovative and baseline technology evaluation and reporting; and
- technology transfer.

Following completion of the LSDP, the IC Team members and its subcontractors are able, and are encouraged, to transfer successful technologies to future deactivation or decommissioning work at other DOE sites and commercial nuclear facilities.

B. Baseline Technology and Approach

The IC Team including the site representative(s), identifies the baseline technology for accomplishing each D&D activity in the project, and establishes its performance specification to assist in comparing and evaluating competing innovative technologies. The baseline technology is generally the technology that the site would use on a particular D&D activity based on past experience at the site.

In some cases, the innovative technology competes directly with the baseline technology in terms of accomplishing the same end condition for the D&D activity. For example, Fernald used an oxy-acetylene torch as a baseline technology to cut a 2-inch metal plate. An oxy-gasoline torch was demonstrated as an innovative technology to cut through the same 2-inch metal plate. In other cases, although the innovative technology can solve the same problem as the baseline technology, the end state of the facility after implementation of both approaches may differ. For example, underground pipe that is suspected of being internally contaminated normally needs to be excavated, surveyed, and appropriately disposed. An innovative technology known as the Pipe Explorer™ was demonstrated at CP-5 to perform nondestructive, in-situ characterization of the interior of the pipe. If the pipe were found to be non-contaminated, it could remain in place. In this case, the Pipe Explorer™ was considered an enabling technology because there are no baseline technologies or approaches that can accomplish the same end condition.

C. Technology Needs and Problems

After identification of baseline technologies and approaches, the IC Team identifies technology needs and problems where an innovative technology could benefit the project. Usually, the technology needs and problems are associated with baseline technologies that perform poorly in terms of high cost, low production rate, large amounts of secondary waste, reluctance of workers to use the technology; issues with worker safety and health, or time delays.

D. Technology Sources

Each IC Team develops a process to identify and select innovative technologies for demonstration. The process ensures that the baseline D&D project is objectively and comprehensively evaluated for problems or technology needs where innovative technologies can make an impact. Once the technology needs of the baseline D&D project have been established, the IC Team proceeds to search for a wide range of technologies to address project needs. An innovative technology suitable for demonstration in an LSDP include one or more of these elements:

- A technology under development, but not yet demonstrated at full-scale
- A new application of an existing technology
- A commercial technology that has not been deployed within DOE

The Fernald Plant 1 and Hanford 105-C Reactor LSDP IC Team management published their technology needs and problems in the Commerce Business Daily and were successful in soliciting vendors with technologies to meet those needs and problems. In other cases, the knowledge of IC Team members and other sources of D&D technology information was used to identify potential technologies for demonstration. Some sources of D&D technology information are presented in Table 3.

Future IC Teams will benefit from an LSDP Technology Information System being developed and maintained by Florida International University working with the first three LSDPs. This LSDP Technology Information System contains general information on all technologies screened by the IC Teams for potential application in their projects. For example, the Technology Information System includes the name of the technology, vendor contact, brief description of technology, technology category, and contact for technology evaluator from the IC Team. Since the LSDP concept discourages multiple demonstrations of a technology for the same application, one objective of the LSDP Technology Information System is to avoid duplication of effort by rescreening technologies already selected for demonstration in another project. In addition, the system will provide another source of potential technologies for demonstration and it will provide an IC Team contact with whom to discuss the previous evaluation of the technology.

Table 3. D&D Technology Information Resources

Resource Name	Internet Address/Contact
FETC/D&D Focus Area	http://www.fetc.doe.gov/products/em/dd.html
EM-50 Information Inventory	http://em-52.em.doe.gov/ifd/infoinventory/ifdfront.htm
Technology Connection (TechCon)	http://www.em.doe.gov/tie/teckcon.html
Global Network of Environmental Technologies (GNET) TechKnow	http://www.gnet.org
Technology Information Exchange (TIE)	http://www.em.doe.gov/tie
Remedial Action Program Information Center (RAPIC)	Park T. Owen, Manager (423) 576-6500
Florida International University - Technology Information System (TIS)	http://www.hcet.fiu.edu
Decommissioning Resource Manual	http://www.em.doe.gov/dd/decresma.html
Preferred Alternative Matrices (PAM)	http://www.em.doe.gov/define/
Phoenix D&D Technology Module 1.0	Paul Lenze, Arrey Industries (304) 367-0007
Strategic Alliance (CP-5 LSDP)	http://www.strategic-alliance.org
Fernald Large Scale Technology Demonstration (Plant -1 LSDP)	http://www.fernald.gov
C-Reactor Interim Safe Storage LSDP	http://www.bhi-erc.com/105c/105c.htm

E. Technology Selection

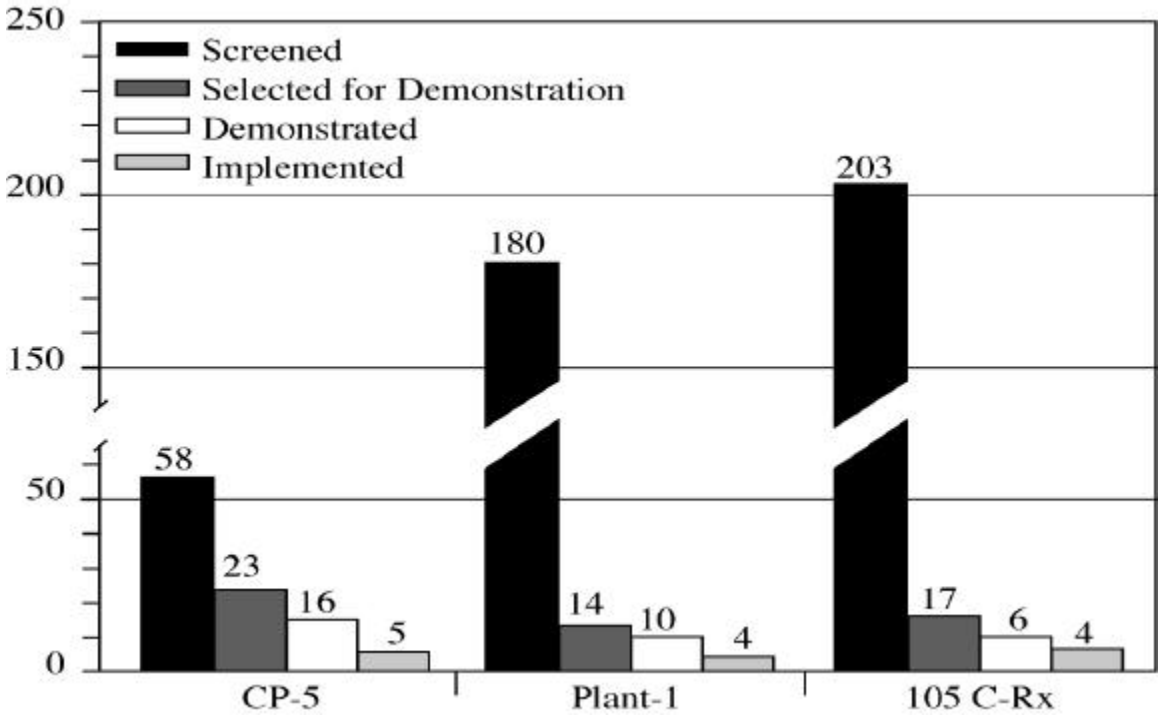
Previous LSDPs have seen success in screening a large number of technologies using a two-tiered approach. The first tier involves criteria with "*Go/No Go*" decision points. These criteria usually include technology maturity, applicability to project, and schedule compatibility. Technologies which pass the initial screening criteria are then reviewed more rigorously as a potential demonstration in the project. Additional criteria used by the IC Teams to screen technologies for demonstration typically includes:

- Application to DOE complex needs
- Ability to adequately measure technology performance
- Demonstration cost
- Expected improvement over baseline (e.g., cost, waste volume, time, safety, radiation exposure)
- Waste minimization
- Technology provider cost-share
- Transportability to the site
- Ability of vendor to provide commercial product or service

The individual(s) that screen the technology also complete technology screening forms to document their review of the technology. They present the results to a Technology Selection Committee (TSC), generally a subgroup of the IC Team, who decide on whether or not to select the technology for demonstration or hold it for later consideration. The IC Team prioritizes technology demonstrations if the TSC selects more technologies than can be supported by the budget.

Following a successful screening, a vendor contract is negotiated and a test plan is prepared by the technology vendor and test engineer. The test plan defines the demonstration including identification of the competing baseline technology to be demonstrated side-by-side with the innovative technology, performance goals, data collection requirements, scope and scale of technology demonstrations, labor and utility requirements, mobilization and demobilization requirements, equipment decontamination requirements, and cost and schedule for the demonstrations. Figure 1 shows the number of technologies screened, selected for demonstration, demonstrated, and deployed within the first three LSDPs as of June 1997.

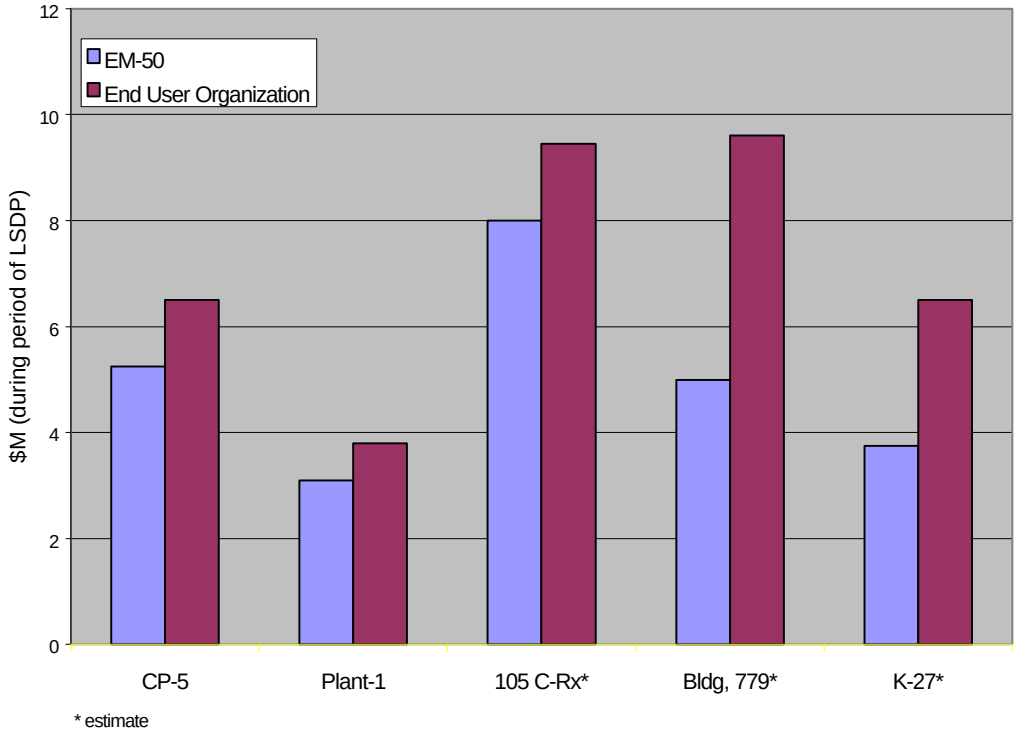
Figure 1. Technology Evaluation and Demonstration Summary Statistics



F. Large-Scale Demonstration Project Costs

The cost of an LSDP is shared by the D&D Focus Area (EM-50) and the owner of the surplus DOE facility. Normally, for decommissioning projects the facility owner is the DOE Office of Environmental Restoration (EM-40) and for deactivation projects the Office of Nuclear Materials and Facility Stabilization (EM-60). The Office of Waste Management (EM-30) is also a potential facility owner and end user of waste minimization and recycling technologies. In general, the project costs associated with demonstrating the innovative technology performance, and monitoring the performance of innovative and baseline technologies are covered by the D&D Focus Area. Cost associated with the use of baseline technologies are provided by either EM-40 or EM-60.

Figure 2. D&D Focus Area and EM End-User LSDP Cost Share



The vendor of an innovative technology is expected to share the cost of their demonstration in return for a rapid avenue to commercialization and acceptance by the end user, regulators, and other stakeholders. In many instances, the vendor contributes the equipment or labor as cost share. Generally, cost share from the technology vendor is greater than 30 percent of the vendor's technology demonstration costs. Funds may also be contributed from other sources, such as the private sector, other offices of DOE, other federal agencies, and state agencies.

G. Demonstration and Data Collection

The IC Team must decide whether the technology demonstration will be performed by the technology vendor, the site (M&O or M&I) contractor, or D&D firms under contract to DOE or the site contractor. This decision is mainly based on the technology vendor's strategy to commercialize the technology, either as a vendor-provided D&D service or sale of equipment. The demonstration should be performed by the staff of the D&D firm performing the baseline activity if the technology is a tool which will replace other tools used by a D&D contractor. In this case, the technology vendor benefits substantially from the feedback of the workers operating the equipment. On the other hand, the technology vendor should perform the technology demonstration if the technology will be commercialized as a vendor service. Other factors which the IC Team considers in this decision are vendor training and site access requirements, D&D contractor training requirements on new equipment, local work rights issues, potential product liability, state of engineering for full-scale use, and equipment decontamination requirements.

The LSDP philosophy seeks to demonstrate innovative technologies side-by-side with the competing baseline technology. Demonstration in this mode ensures a fair comparison of the new technology and meaningful cost and performance data for dissemination throughout the DOE complex. Simultaneous, or near simultaneous, demonstration mitigates performance differences caused by variations in environmental conditions, data collection, or performance interpretation. In some cases, it may be possible to use the same work crew to perform the baseline and innovative technology demonstrations.

When the demonstrations begin, the innovative and baseline technologies must be operated through a start-up and familiarization period before generating meaningful cost and performance data. A few days of operation is needed for the startup period for baseline technologies. Innovative technologies may require one week or more before they are operating at peak efficiencies of equipment and workers. Problems are routinely experienced during mobilization, initial start-up, and crew training and occasionally, workers will make minor modification to the equipment to improve its operability during the demonstration. Additionally, the operating crew may identify more significant improvements to the design and operation of a technology which will enhance the performance and assist the developer in improving the commercial viability of the technology. To complete a meaningful demonstration, the IC Team must ensure that the technology demonstration allows for sufficient time and test area to overcome this "learning curve" and reach peak performance during the demonstration period. The IC Team should also consider a contingency in the contract to allow for additional operating time if the technology shows the potential for enhanced performance.

A successful demonstration is defined as one where both an innovative and baseline technology have been demonstrated under comparable conditions and sufficient data has been collected to complete a meaningful cost and performance evaluation. The success of the demonstration does not depend on proving the superior performance of the innovative technology. While the expectation of superior performance is a necessary condition to select an innovative technology for demonstration, the objective of the demonstration is to determine the validity of that hypothesis. If a technology does not perform as expected or to its full potential, it is the responsibility of the IC Team to provide constructive comments on the potential for further enhancements of the technology which may improve the cost or performance of the technology. To complete a successful demonstration, the IC Team must invest adequate resources during the planning process to ensure collection of necessary cost and performance data.

H. Cost and Performance Evaluation

Through an interagency agreement, the D&D Focus Area has acquired the services of the U.S. Army Corps of Engineers (USACE) to complete uniform and unbiased cost analysis of each baseline and innovative technology demonstrated under all LSDPs. Therefore, the USACE is involved in developing the test plan to ensure inclusion of appropriate data collection requirements. During the demonstration, including mobilization and demobilization activities, test engineers and team members from the USACE provide oversight and record the necessary cost and performance data. In many cases, particularly when worker protective clothing and equipment are being demonstrated, follow-on interviews with the workers will take place to discuss and record more subjective performance issues such as ease of use, comfort, equipment noise levels, and other health, safety and ergonomic factors.

The USACE is responsible for preparing a detailed cost analysis report for each technology demonstration and a summary of the report which is included in the IC Team's Innovative Technology Summary Report (ITSR). The USACE uses a standardized cost estimating methodology accepted by the Federal Remediation Technologies Roundtable for uniform reporting of environmental technology performance. The costs are based on data observed during the technology demonstration and site-specific cost factors such as labor, utilities, waste disposal, and safety rules. The cost analysis is based on application of the technology for the same application for which it was demonstrated. Generally, data obtained while the technology is operating at its peak performance during the demonstration is used in the cost analysis. Cost is based on application of the demonstrated technology at a realistic scale for commercial deployment of the technology, which may or may not differ from the scale of the technology demonstration. For example, a technology may be demonstrated to decontaminate only 100 ft^2 of concrete floor because of funding or floor space limitations, but the cost analysis is based on decontaminating 2,000 ft^2 because it is more realistic of the scale of a commercial D&D activity. This approach tends to downplay technology mobilization and demobilization cost which would dominate the costs if the cost analysis were based on application of the technology to 100 ft^2 of concrete floor.

I. Technology Documentation and Communication

The effective communication of demonstration results is the most critical aspect of the LSDP. The results of the demonstration must be conveyed in a format which is readable and meaningful to prospective end users of each technology. The primary vehicle selected by OST for documentation of final demonstration performance of innovative technologies is the Innovative Technology Summary Report. The ITSR includes a summary of the cost and performance information collected during the demonstration. The IC Team is responsible for delivering an ITSR for each innovative technology demonstrated as part of their project. The IC Team must submit a complete ITSR, including the USACE cost analysis, for review by the D&D Focus Area and subsequent publication. Additionally, because the ITSR is only a summary document, the IC Team is responsible for the completion of a detailed report of each demonstration which includes all the data and backup calculations for information presented in the ITSR.

In addition to the ITSR, within two weeks following the technology demonstration, the IC Team prepares a one or two-page fact sheet. The purpose of the fact sheets is to rapidly communicate and disseminate information to the technology end users. The fact sheets provide a brief description of the technology and the demonstration including preliminary results, and provides names and phone numbers of key individuals who can provide further information on the demonstration.

Each IC Team is also required to prepare a communication plan for the entire project. The communication plan includes specific approaches to communicate project status, progress, issues and accomplishments with other LSDPs, the D&D Focus Area, the DOE weapons complex, D&D firms, regulators and tribal and public stakeholders. A key element of the LSDPs communication outreach is the establishment of an Internet home page to provide information on planned and completed demonstrations as well as other aspects of the LSDP. The homepages for the first three LSDPs are included in Table 3.

In addition, LSDP results are communicated through frequent meetings with IC Teams on other projects, presentations and papers at national and international D&D conferences, presentations at Site Technology Coordination Group meetings, live demonstration of technologies, American Society of Mechanical Engineers technical peer review, and the D&D Focus Area's Mid-Year Review meeting. Meetings with other IC Teams often involve discussions on lessons learned to continuously improve the management and conduct of all LSDPs.

In April 1997, the first three LSDPs were reviewed by the American Society of Mechanical Engineers. All three projects were found to have no major deficiencies. The National Academy of Sciences has also informally reviewed the CP-5 and FEMP Plant 1 LSDP during site visits.

IV. TECHNOLOGY DEPLOYMENT

The strongest statement a DOE site can make about the performance of an innovative technology is that it has been incorporated into the baseline project. To date, 13 technologies demonstrated within an LSDP have been deployed by the site to continue or to complete the D&D baseline activities (see Table 4) and three additional technologies are being considered. The incorporation of these technologies into the site's baseline D&D project validates the initial success of the D&D Focus Area's Large-Scale Demonstration Program. However, in today's environment of EM budget constraints, the true measure of a program's success is wide-spread commercialization and deployment of alternative technologies or innovative processes.

In response to this goal, OST has established the Technology Deployment Initiative. The TDI will provide the means and incentives to DOE sites to identify and deploy technologies and processes for clean-up throughout the DOE complex. Specifically, the mission of the TDI is to deploy technologies and processes that reduce the cost, accelerate site clean-up, and support EM goals and schedules. To accomplish this mission the TDI Program is looking for technologies or processes that do not require additional demonstration or testing, and which have sufficient performance data to warrant a high degree of confidence of the benefits it can provide to DOE. Technology deployment has been defined as implementation of a technology at multiple sites, multiple implementation of a technology at a single DOE site, or multiple site usage of a centralized technology.
The LSDP concept provides a sound, tested approach to qualify D&D technologies for the TDI. Technologies demonstrated at full scale within an LSDP and that show clear cost and performance advantages over the competing baseline technology are available to move directly into the TDI. Documentation of the demonstration via the ITSR and third party validation of the cost and performance of the technology by the USACE help to support TDI requirements. In addition, the IC Team concept promotes the partnerships between DOE operations offices, industry and academia desired by the TDI.

Table 4. Technologies Implemented Following LSDP Demonstration

Technology Name	Application
Chicago Pile 5 Test Reactor Facility	
Dual Arm Work Platform	Reactor regulator rod sizing and packaging
Swing Reduced Crane	Material and equipment handling
Rosie Mobile Work System	Reactor vessel dismantlement and packaging
Empore Membrane	Decontamination of fuel pool water
GammaCam ™	Reactor/biological shield characterization
Plant 1 Uranium Processing Facility	
Oxy-Gasoline Torch	Equipment cutting and sizing
VecLoader HEPA VAC	Insulation removal
Low-Density Cellular Concrete	Void filling for equipment disposal
Pipe Inspection System	Pipe characterization for free release
105-C Reactor Facility	
Temporary Power and Light System	Portable power, communication, safety, and alarm system in support of interim safe storage activities
Position-Sensitive Radiation Detection Monitor	Pinpoint detection of external alpha & beta contamination
Laser Assisted Ranging and Data System	Indoor alpha & beta characterization
STREAM (System for Tracking Remediation, Engineering, Activities and Materials) *	D&D planning and project management

* STREAM has had multiple deployments; Hanford 105 C-Reactor, Savannah River Heavy Water Component Test Reactor, and Chernobyl.

To date, seven technologies previously demonstrated at one of the D&D Focus Area's LSDPs have been included for further DOE deployment within the proposals selected for award under the TDI. These technologies include:

- Oxy-gasoline Torch (Petrogen)
- VecLoader HEPA VAC (Vector Technologies Ltd.)
- Laser Induced Fluorescence Imaging (Special Technologies Laboratory)
- GammCam ™ (AIL Systems, Inc.)
- Concrete Scabbler (Pentek)
- RadScan 600 (BNFL)
- Pipe Explorer ™ (Science and Engineering Associates, Inc.)

V. FUTURE LARGE-SCALE DEMONSTRATION PROJECTS

The D&D Focus Area will complete the LSDPs at Argonne National Laboratory and FEMP in early and mid FY1998. The Hanford 105-C Reactor project will continue throughout FY1998 and the two recently selected LSDPs at Rocky Flats and Oak Ridge will be demonstrating technologies in FY1998 and FY1999. Between FY1999 and FY2002, the D&D Focus Area plans to complete an additional three LSDPs. In order to address at least 90 percent of the DOE's D&D problems and needs, it is likely that the facilities selected for the last three LSDPs will be facilities different in type and contamination from the first five facilities (e.g., tritium facility, laboratory facility with highly contaminated hot cells, fuel reprocessing facility, weapons assembly/disassembly facility).

VI. CONCLUSION

The D&D Focus Area believes that the Large-Scale Demonstration Program is DOE-EM's best approach to demonstrate and deploy innovative technologies across the DOE weapons complex. D&D workers from the site have discovered the real performance of baseline technologies by demonstrating them side-by-side with the innovative technology. Often, the relatively poor performance of the baseline technology was a "reality check" for the site's D&D workforce, who did not realize the relatively poor performance and high cost of a baseline technology until data was collected and analyzed from the technology demonstration.

We are just beginning to reap the substantial benefits of this creative approach as confirmed by the fact that several demonstrated technologies have been adopted as new baseline technologies at DOE sites. Other benefits which are unique to the LSDP approach include:

- Direct transfer of innovative technologies to experienced D&D firms
- Demonstration of multiple innovative technologies in an active D&D project
- Side-by-side comparison of baseline and innovative technologies
- Independent analysis of cost and other performance factors
- Demonstration of technologies developed outside of EM-50's technology development program
- Scale and scope of the technology demonstrations is defined by the end user
- Opportunities for technology vendors to immediately deploy technologies following successful technology demonstrations
- Technology demonstrations assist the DOE site in decommissioning its facility because the demonstrations occur in an active D&D project.

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